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ESTABLISHING THE CREDIBILITY OF BIOLOGICAL DATA

Since 1988, staff at the Dorset Research Centre have collected chemical and biological data as part of a federal/provincial programme to monitor the recovery of lakes and rivers due to reductions in the long-range transport of airborne pollutants. Biological data are often sensitive indicators of impaired water quality because the biota integrate the impacts of many stressors over time and space. By contrast, atypical chemical events may be missed despite intensive sampling because unusual events are infrequent and often span relatively short time periods. Moreover, the wrong chemicals or stressors may be measured.

In lakes and rivers, biological assessments frequently involve collections of bottom-dwelling invertebrates. The resultant counts of the different species from each sampling area comprise the raw data that are summarized into indices such as the total number of species, the total number of individuals, and so on. Unlike assessments based on water and sediment chemistry, guidelines and standards for biological indices are generally lacking. Consequently biological data are evaluated by comparison to relatively unimpacted or control locations. Because natural variability affects these types of comparisons, the credibility of the results can be challenged.

Unlike chemical analyses where instruments are routinely calibrated and data are verified with samples of known concentrations, quality assurance and quality control protocols (i.e., QA/QC) for biological data are less common. Quality assurance requires documented standard operating procedures, plus data recording, management and verification protocols, as well as regular performance evaluations. Quality control provides data quality objectives that specify data accuracy, precision and completeness to guarantee that the resultant data are truly representative and comparable. When used together, QA/QC methods ensure data integrity and credibility. Although quality assurance protocols are used in biological assessments, quality control procedures that establish data accuracy and precision are often lacking.

In a recent report, the credibility of the data used in biological assessments has been evaluated. The data in question originated from repeated assessments of bottom-dwelling invertebrates found in the shallow areas of small lakes. Each fall, staff at the Dorset Research Centre sample the nearshore invertebrates in five small lakes in order to detect anticipated changes in the health of representative lakes in south-central Ontario. Standard operating procedures were developed through consultation between federal and provincial agencies in the Long-Range Transport of Airborne Pollutants (LRTAP) Programme. Members of this programme use the resultant standard operating procedures to collect data from lakes and rivers in six areas of eastern Canada. The data are stored in a shared database that will be used to examine local and regional responses to emission reductions. An additional objective of the Dorset study was to develop simple quality control (QC) procedures to establish the reliability and hence, credibility of the biological data.

In chemical analyses, QC checks include the regular use of standards of known concentrations, plus blank, split and spiked samples. Because samples of invertebrates are relatively fragile, standards, blanks and spiked samples are almost impossible to manufacture. As a result, only split or replicated samples can be used to assess the accuracy and precision of most biological samples.

To this end, five sites in each of three lakes were sampled repeatedly in order to estimate the importance of sampling on different dates relative to observed differences among the five sites in each lake. By comparing samples collected on the same day, samples collected each week and samples collected every six weeks, the report established when differences among the five sites within a lake became blurred by temporal artifacts associated with sampling on different dates. Coefficients of variation were used to summarize precision, whereas accuracy was estimated by a measure of repeatability based on variance components from an analysis of variance (i.e., ANOVA). With this replicated design and the use of variance components, the QC data can be linked directly to field data.

From this assessment, the LRTAP sampling protocol proved to have moderate repeatability and precision for the relative abundances of many invertebrate taxa when samples are collected over a three-week period. These major groups include aquatic worms, amphipods, dragonflies, aquatic beetles, most midges and clams. By contrast, the relative abundances of snails, leeches, caddisflies and stoneflies are not very useful. In addition, the repeatability and precision of almost all of the taxonomic groups becomes unacceptable if samples are collected every six weeks over the ice-free season.

The development of QA/QC tools for biological assessments has far-reaching implications. With rigorous QA/QC, biological data will have the same credibility as chemical data. Moreover, the greater sensitivity of the biological data will enhance our monitoring capabilities. Additionally, these QA/QC tools can be used to fine-tune the various biological sampling protocols to ensure that pre-specified affects can be detected. For instance, these same QA/QC approaches are currently used in an ongoing Dorset initiative to develop rapid bioassessment methods that provide inexpensive, accurate biological assessments requiring a minimum of taxonomic expertise.

The report outlining the biological QA/QC protocol and associated analysis was published in the Canadian Journal of Fisheries and Aquatic Sciences (Reid, R.A., K.M. Somers and S.M. David. 1995. Spatial and temporal variation in littoral-zone benthic invertebrates from three south-central Ontario lakes. Can. J. Fish. Aquat. Sci. **52**: 1406-1420).

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Figure 1. Ron Ingram completing a nearshore substrate assessment prior to sampling the benthic invertebrates